Ants (Hymenoptera: Formicidae) in different green areas in the metropolitan region of Salvador, Bahia state, Brazil

Article *in* Brazilian journal of biology = Revista brasleira de biologia · April 2021

DOI: 10.1590/1519-6984.236269

Brazilian Journal of Biology

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Notes and Comments

Ants (Hymenoptera: Formicidae) in different green areas in the metropolitan region of Salvador, Bahia state, Brazil

T. S. Melo[a,b,c*], E. B. A. Koch[a,b], A. R. S. Andrade[a,b,c], M. L. O. Travassos[a,b,c], M. C. L. Peres[c] and J. H. C. Delabie[a,b]

[a]Universidade Federal da Bahia – UFBA, Programa de Pós-graduação em Ecologia, Salvador, BA, Brasil

[b]Laboratório de Mirmecologia, Convênio entre Comissão Executiva do Plano da Lavoura Cacaueira – CEPLAC e Universidade Estadual de Santa Cruz – UESC, Ilhéus, BA, Brasil

[c]Universidade Católica do Salvador – UCSal, Centro de Ecologia e Conservação Animal, Salvador, BA, Brasil

One of the main causes for biodiversity loss is urbanization, mostly due to city growth in highly diverse areas and priority conservation areas, such as the Atlantic Forest (Brasil, 2002; Melo and Delabie, 2017; Conservation International, 2019). Some of the major motivations for the conservation of urban biodiversity, include the preservation of local diversity, the protection of important populations and rare species, as well as the provision of ecosystem services (Dearborn and Kark, 2010). To achieve this, it is essential to understand species diversity and distribution in urban areas.

In urban environments, green areas are important habitats for conservation as they house a large number of species (Nielsen et al., 2014; Melo and Delabie, 2017). With more than 16 thousand species/morph species of described ants (Bolton, 2019), data on ants in urban environments has increased worldwide over the last 20 years, with the majority of studies being focused on species distribution (Santos, 2016). In Brazil, more than 490 ant species have been recorded in urban green areas (Melo and Delabie, 2017), with a large number of species being registered in the city of Salvador, Bahia (Melo et al., 2014; Melo and Delabie, 2017). Thus, with the aim of increasing the available knowledge on the ant species from Salvador, recorded by Melo et al. (2014), we present an ant checklist with additional data for their occurrence in green areas.

Ants were collected in Salvador, Bahia, Brazil (12°58'S 38°30'W), between April and June 2019 at 62 sample points (SP). At each sample point we removed an area of leaf litter of size 50 × 50cm and installed a bait line as described below. Four green area categories were sampled: fragment (25 samples), road median strip (18), squares (13) and vacant lots (6), totaling 62 samples (Table 1). The SPs were at least 100 meters apart. At each SP we sampled the leaf litter and plants to ensure the detection of ant diversity. To sample the leaf litter fauna, we used a Winkler extractor in units of 50 × 50 cm, where we left the collected material exposed for 24h for fauna extraction. We collected the vegetation fauna in arboreal strata with the adapted bait line technique (Leponce et al., 2019). This technique consists of putting a rope over the top of a tree, using a slingshot. We allocated baits every two meters along the rope from one meter above soil level to the highest tree point, and left them for three hours. We conducted surveys with authorization licenses nº 62268-1 from MMA/SISBIO and nº 2018-003254/TEC/PESQ-0006 from INEMA/DIRUC. The identification of morph species was acheived following Melo et al. (2014) and species nomenclature followed Bolton (2019). Ants were deposited in the collection of the Laboratório de Mirmecologia (CPDC, curator: J. Delabie), at the Comissão Executiva do Plano da Lavoura Cacaueira (CEPLAC, Itabuna, Bahia, Brazil), voucher #5846. We evaluated the variation in ant species richness according to the type of sampling method and the different types of green areas sampled. Additionally, we measured the similarity between green area types (fragment, road median strip, public square and vacant lots), and we used a Permutational Analysis of Variance (PERMANOVA), with Jaccard's similarity index as the association measure to evaluate differences in ant species composition. Rarefaction curves and Non-Metric Multidimensional Scaling (NMDS, Jaccard's distance) were produced in order to compare the richness between the environments. The statistical analyzes were performed using PAST 4.02 software (Hammer et al., 2001).

We collected 93 ant species/morph species of 39 genera and six subfamilies (Table 2). Myrmicinae was the richest (S = 57 species), followed by Ponerinae (S = 12), Formicinae (S = 9), Dolichoderinae (S = 7), Pseudomyrmecinae (S = 4), Ectatomminae (S = 3), and Amblyoponinae (S = 1). In Brazil, Melo and Delabie (2017) found a high number of species in urban environments from Atlantic Forest.

Five cities in the metropolitan region of Salvador (Bahia, S = 198 species) (Melo et al., 2014), ten cities in an inland city in Santa Catarina (S = 140) (Lutinski et al., 2013), three cities at Alto Tietê (São Paulo, S = 86) (Munhae et al., 2009), and the city of São Paulo (São Paulo, S = 79) (Morini et al., 2007), presented the same number of species found in this study, even

*e-mail: terciosilvamelo@hotmail.com
Received: April 7, 2020 – Accepted: July 23, 2020

Table 1. Description of green areas sampled and sampling effort in the city of Salvador, Bahia, Brazil.

Green area	Characteristics	Number of samples
Fragment	Natural environment, without environmental management and with canopy formation	25
Road median strip	Artificial environment located on the side of streets, under environmental management and without canopy formation	18
Public square	Artificial environment used for recreation, under environmental management and without canopy formation	13
Vacant lots	Artificial environment without human use, environmental management and canopy formation	6

Table 2. List of ant species collected in the city of Salvador, Bahia, Brazil, between April and June of 2019.

Subfamily / Specie	Sampling technique	Habitat	Occurrence (%)
Amblyoponinae			
Prionopelta antillana Forel, 1909 *	W	R, F and S	6.45
Dolichoderinae			
Azteca prox. *alfari* *	B	F and S	3.22
Azteca severini Emery, 1896 *	B	F and S	3.22
Dolichoderus smithi MacKay, 1993 *	W	S	1.61
Dorymyrmex pyramicus (Roger, 1863) *	B	R, F and S	19.35
Dorymyrmex sp.1	B	R and S	3.22
Linepithema neotropicum Wild, 2007	B	R, F and V	6.45
Tapinoma melanocephalum (Fabricius, 1793)	B and W	R, F and S	22.58
Ectatomminae			
Ectatomma brunneum Smith, 1858 *	W	F	1.61
Ectatomma edentatum Roger, 1863 *	W	R and F	12.9
Ectatomma tuberculatum (Olivier, 1792)	B	F	11.29
Formicinae			
Brachymyrmex admotus Mayr, 1887 *	B and W	R, F, S and V	29.03
Brachymyrmex heeri Forel, 1874	B and W	R, F and V	11.29
Camponotus blandus (Smith, 1858)	B and W	F, S and V	4.83
Camponotus fastigatus Roger, 1863	B and W	R, F and V	16.12
Camponotus novogranadensis Mayr, 1870	B and W	R and V	4.83
Camponotus vittatus Forel, 1904	B and W	F	3.22
Myrmelachista sp.1 *	B	R	1.61
Nylanderia fulva (Mayr, 1862) *	W	F and V	4.83
Paratrechina longicornis (Latreille, 1802)	B and W	R, F, S and V	12.9
Myrmicinae			
Acromyrmex balzani (Emery, 1890) *	W	F	1.61
Acromyrmex rugosus (Smith, 1858)	B and W	R and S	4.83
Acromyrmex subterraneus brunneus (Forel, 1912)	W	F	4.83
Basiceros scambognathus (Brown, 1949) *	W	F	3.22

*New record for Salvador. Occurrence = percentage of each species in the sample points; B = Bait line; W = Winkler extractor; F = Fragment; R = Road median strip; S = Public square; V = Vacant lots.

Table 2. Continued...

Subfamily / Specie	Sampling technique	Habitat	Occurrence (%)
Myrmicinae			
Cardiocondyla obscurior Wheeler, 1929	B and W	R and S	8.06
Carebara sp.1	W	F	3.22
Carebara sp.2 *	W	S	1.61
Cephalotes atratus (Linnaeus, 1758) *	B	F	1.61
Cephalotes maculatus (Smith, 1876) *	W	F	1.61
Cephalotes minutus (Fabricius, 1804)	B and W	R and S	3.22
Crematogaster erecta Mayr, 1866	B	R, F and V	16.12
Crematogaster limata Smith, 1858	B and W	R and F	11.29
Crematogaster victima Smith, 1858	B and W	R, F and S	8.06
Cyphomyrmex rimosus (Spinola, 1851)	W	R and F	6.45
Cyphomyrmex transversus Emery, 1894	W	R, F, S and V	8.06
Megalomyrmex drifti Kempf, 1961 *	W	F	1.61
Monomorium floricola (Jerdon, 1851)	B and W	R, F, S and V	48.38
Mycetomoellerius sp.1	W	R and F	9.67
Mycetomoellerius sp.2	B	R	1.61
Mycocepurus goeldii (Forel, 1893)	W	R and F	6.45
Octostruma balzani (Emery, 1894)	W	F	1.61
Octostruma iheringi (Emery, 1894)	W	F	6.45
Paratrachymyrmex sp.2 *	W	F	1.61
Pheidole (complex flavens) sp.2	B and W	R, F and S	17.74
Pheidole (group diligens) sp.27	W	F	1.61
Pheidole (group fallax) sp.13	B and W	R and F	4.83
Pheidole (group fallax) sp.6	B and W	F	8.06
Pheidole (group fallax) sp.8	B and W	R, F and S	11.29
Pheidole (group flavens) sp.21	B and W	R and F	8.06
Pheidole (group flavens) sp.23	B and W	R, F and V	11.29
Pheidole megacephala (Fabricius, 1793) *	B and W	R, F, S and V	59.67
Pheidole obscurithorax Naves, 1985	B and W	R and V	3.22
Pheidole radoszkowskii Mayr, 1884	B and W	F and S	17.74
Pheidole synarmata Wilson, 2003	W	S	1.61
Rogeria foreli Emery, 1894 *	W	F and V	3.22
Rogeria sp.1 *	W	F	1.61
Rogeria subarmata (Kempf, 1961) *	B	F	1.61
Sericomyrmex bondari Borgmeier, 1937 *	W	F	1.61
Solenopsis geminata (Fabricius, 1804)	W	R, F and S	8.06
Solenopsis globularia (Smith, 1858)	W	R, S and V	6.45
Solenopsis pollux Forel, 1893 *	B and W	R, F, S and V	11.29
Solenopsis saevissima (Smith, 1855) *	B and W	R and V	3.22
Solenopsis sp.1	B and W	R, F, S and V	56.45
Solenopsis sp.2	W	F and S	17.74

*New record for Salvador. Occurrence = percentage of each species in the sample points; B = Bait line; W = Winkler extractor; F = Fragment; R = Road median strip; S = Public square; V = Vacant lots.

Table 2. Continued...

Subfamily / Specie	Sampling technique	Habitat	Occurrence (%)
Myrmicinae			
Solenopsis sp.4	W	F	3.22
Solenopsis sp.6	W	F	1.61
Strumigenys carinithorax Borgmeier, 1934 *	W	R, F, S and V	33.87
Strumigenys denticulata Mayr, 1887	W	F, S and V	22.58
Strumigenys precava Brown, 1954 *	W	F	6.45
Strumigenys subedentata Mayr, 1887	W	F	1.61
Tetramorium bicarinatum (Nylander, 1846)	B	R	1.61
Tetramorium lucayanum (Latreille, 1802)	B and W	F, S and V	6.45
Tetramorium simillimum (Smith, 1851)	W	R and S	6.45
Wasmannia auropunctata (Roger, 1863)	B and W	R, F and V	24.19
Wasmannia rochai Forel, 1912	B and W	F and S	4.83
Wasmannia sp.1 *	W	F	1.61
Xenomyrmex sp.1 *	B	F	3.22
Ponerinae			
Anochetus diegensis Forel, 1912 *	W	R, F, S and V	11.29
Hypoponera sp.1	W	F	8.06
Hypoponera sp.2	W	F	6.45
Hypoponera sp.3	W	R, F, S and V	16.12
Hypoponera sp.4	W	R and F	11.29
Hypoponera sp.5	W	F	3.22
Leptogenys pusilla (Emery, 1890) *	W	F	1.61
Odontomachus bauri Emery, 1892	W	S	1.61
Odontomachus haematodus (Linnaeus, 1758)	B and W	F	3.22
Odontomachus meinerti Forel, 1905	W	F	3.22
Pachycondyla harpax (Fabricius, 1804)	W	V	1.61
Thaumatomyrmex sp.1 *	W	F	1.61
Pseudomyrmecinae			
Pseudomyrmex (group pallidus) sp.5 *	B	F	1.61
Pseudomyrmex curacaensis (Forel, 1912) *	B	S	1.61
Pseudomyrmex gracilis (Fabricius, 1804)	B	F and S	3.22
Pseudomyrmex schuppi (Forel, 1901) *	B and W	R and S	3.22
RICHNESS		**93**	

*New record for Salvador. Occurrence = percentage of each species in the sample points; B = Bait line; W = Winkler extractor; F = Fragment; R = Road median strip; S = Public square; V = Vacant lots.

when implementing different sampling techniques and efforts. In these cities, representatives of Myrmicinae were found to have the highest richness followed by Formicinae and Ponerinae (Morini et al., 2007; Munhae et al., 2009; Lutinski et al., 2013; Melo et al., 2014). Melo et al. (2014) recorded 164 species in the city of Salvador however, we reported 34 new species, increasing the number of ant species in Salvador urban green areas to 198.

A higher number of species was found in the leaf litter (Winkler extractor, S = 77; 46 exclusive species) than in the vegetation (bait line, S = 47; 16 exclusive species). Ant assemblage composition shows important differences according to strata (mostly in soil when compared to vegetation) (Wilson and Hölldobler, 2005). Thus, a lower richness of arboreal species is expected as evolutionary history shows that ground ants specialize in resource selection, nesting places, and dispersal mechanisms and

therefore, have an advantage when compared to vegetation assemblages (generalists) (Wilson and Hölldobler, 2005). The sampling technique may be related to the lower arboreal richness observed, since baits can attract only a proportion of ant assemblies. Despite the recorded arboreal ant richness, nine new species were sampled: *Azteca* prox. *alfari*, *A. severini* Emery, 1896, *Cephalotes atratus* (Linnaeus, 1758), *Dorymyrmex pyramicus* (Roger, 1863), *Myrmelachista* sp.1, *Pseudomyrmex* sp.5 (group *pallidus*), *P. curacaensis* (Forel, 1912), *Rogeria subarmata* (Kempf, 1961) and *Xenomyrmex* sp.1.

Among the different types of green urban areas, forest fragments showed higher richness (S = 74 species; 32 exclusive species), followed by road median strips (S = 44; three exclusives), squares (S = 37; five exclusives), and vacant lots (S = 26; one exclusive) (Figure 1 and 2). We detected significant differences in ant species composition according to the type of green areas ($F_{3,58} = 2.07$; $p < 0.001$). Ant assemblages from road median strips and public squares were 42% more similar and 35% of those were similar to ants from vacant lots (Figure 3). Ants from forest fragments were 30% similar to all other green urban areas here studied. We recorded 10 species common to all green areas: *Anochetus diegensis* Forel, 1912, *Brachymyrmex admotus* Mayr, 1887, *Cyphomyrmex transversus* Emery, 1894, *Hypoponera* sp.3, *Monomorium floricola* (Jerdon, 1851), *Paratrechina longicornis* (Latreille, 1802), *Pheidole megacephala* (Fabricius, 1793), *Solenopsis pollux* Forel, 1893, *Solenopsis* sp.1 and *Strumigenys carinithorax* Borgmeier, 1934 (Table 2). A high richness of native ants has been reported in cities with different levels of anthropogenic disturbance (Santos, 2016; Melo and Delabie, 2017). Conserved environments, such as native fragments, have higher ant species richness

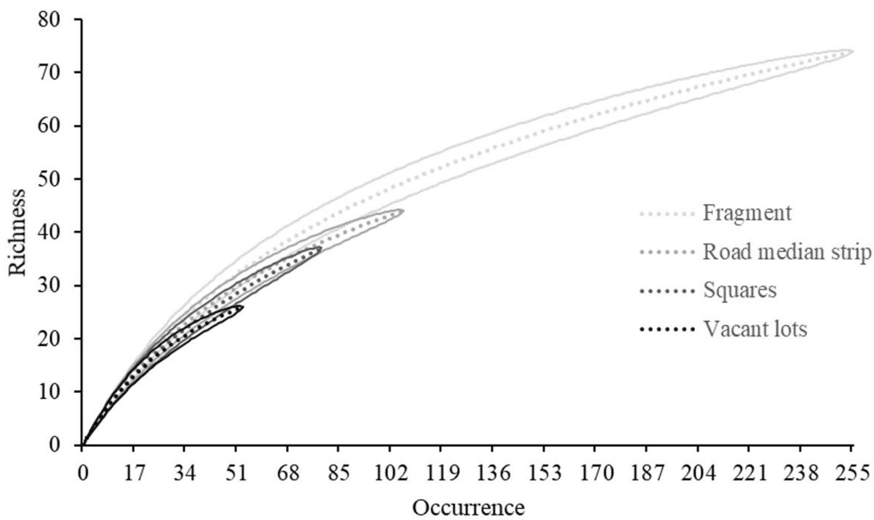

Figure 1. Rarefaction curve (dotted line) comparing the ant richness of different green areas studied in Salvador, Bahia, Brazil. Continuous line: confidence interval.

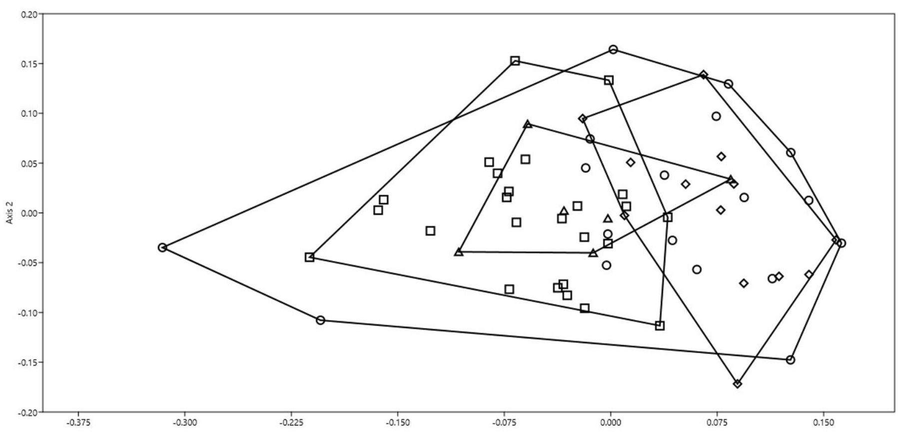

Figure 2. Distribution of the ant assemblages found in different green areas in Salvador, Bahia, Brazil. Circle = Road median strip; Square = Fragment; Diamond = Public square; Triangle = Vacant lots.

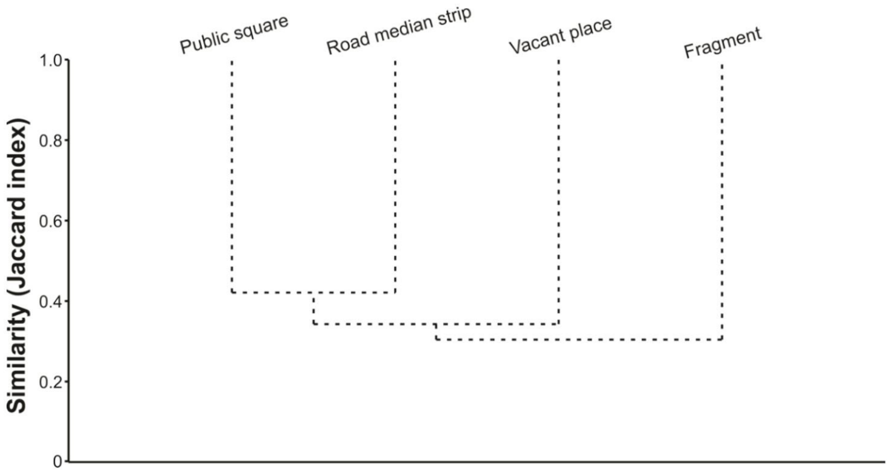

Figure 3. Comparison of the ant assemblages found in different green areas in Salvador, Bahia, Brazil, through a similarity dendrogram.

compared to impacted ones such as road median strips, public squares, and vacant lots (Melo and Delabie, 2017). Therefore, we highlight the importance of maintaining more conserved green areas in order to preserve ant species. Although additional research and methods would allow for the detection of more ant species, this study has deepened the knowledge available on ants from Salvador.

Acknowledgements

Thanks are given to the Ministério do Meio Ambiente – MMA and Instituto do Meio Ambiente e Recursos Hídricos – INEMA for the collection permits, to Icaro Silva e Mendonça and Lais Leal Lopes for reviewing the English text and anonymous reviewers for contributions. TSM thanks CAPES for the scholarship provided and JHCD acknowledges his research grant from CNPq (process 304629/2018-9).

References

BOLTON, B. 2019 [viewed 11 November 2019]. *AntWeb: versão 8.6.6* [software]. Available from: http://www.antweb.org

BRASIL. Ministério do Meio Ambiente – MMA, 2002. *Biodiversidade brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição dos benefícios da biodiversidade nos biomas brasileiros*. Brasília: Secretaria de Biodiversidade e Florestas, 404 p.

CONSERVATION INTERNATIONAL, 2019 [viewed 12 December 2019]. *Biodiversity hotspots* [online]. Available from: https://www.conservation.org/priorities/biodiversity-hotspots

DEARBORN, D.C. and KARK, S., 2010. Motivations for conserving urban biodiversity. *Conservation Biology*, vol. 24, no. 2, pp. 432-440. http://dx.doi.org/10.1111/j.1523-1739.2009.01328.x. PMid:19775276.

HAMMER, O., HARPER, D.A.T. and RYAN, P.D., 2001. PAST: paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, vol. 4, no. 1, pp. 9p.

LEPONCE, M., DELABIE, J.H.C., ORIVEL, J., JACQUEMIN, J., CALVO-MARTIN, M. and DEJEAN, A., 2019. Tree-dwelling ant survey (Hymenoptera, Formicidae) in Mitaraka, French Guiana. *Zoosystema*, vol. 41, no. 10, pp. 163-179. http://dx.doi.org/10.5252/zoosystema2019v41a10.

LUTINSKI, J.A., LOPES, B.C. and MORAIS, A.B.B., 2013. Diversidade de formigas urbanas (Hymenoptera: Formicidae) de dez cidades do sul do Brasil. *Biota Neotropica*, vol. 13, no. 3, pp. 332-342. http://dx.doi.org/10.1590/S1676-06032013000300033.

MELO, T.S. and DELABIE, J.H.C., 2017. Ecologia e conservação da biodiversidade de formigas em ambientes urbanos. In: O.C. BUENO, A.E.C. CAMPOS and M.S.C. MORINI, eds. *Formigas em ambientes urbanos no Brasil*. Bauru: Canal 6, pp. 189-240.

MELO, T.S., PERES, M.C.L., CHAVARI, J.L., BRESCOVIT, A.D. and DELABIE, J.H.C., 2014. Ants (Formicidae) and Spiders (Araneae) listed from the Metropolitan Region of Salvador, Brazil. *Check List*, vol. 10, no. 2, pp. 355-365. http://dx.doi.org/10.15560/10.2.355.

MORINI, M.S.C., MUNHAE, C.B., LEUNG, R., CANDIANI, D.F. and VOLTOLINI, J.C., 2007. Comunidades de formigas (Hymenoptera, Formicidae) em fragmentos de Mata Atlântica situados em áreas urbanizadas. *Iheringia*, vol. 97, no. 3, pp. 246-252. http://dx.doi.org/10.1590/S0073-47212007000300005.

MUNHAE, C.B., BUENO, Z.F.N., MORINI, M.S.C. and SILVA, R.R., 2009. Composition of the ant fauna (Hymenoptera: Formicidae) in public squares in Southern Brazil. *Sociobiology*, vol. 53, no. 2, pp. 455-472.

NIELSEN, A.B., VAN DEN BOSCH, M., MARUTHAVEERAN, S. and VAN DEN BOSCH, C.K., 2014. Species richness in urban parks and its drivers: a review of empirical evidence. *Urban Ecosystems*, vol. 17, no. 1, pp. 305-327. http://dx.doi.org/10.1007/s11252-013-0316-1.

SANTOS, M.N., 2016. Research on urban ants: approaches and gaps. *Insectes Sociaux*, vol. 63, no. 3, pp. 359-371. http://dx.doi.org/10.1007/s00040-016-0483-1.

WILSON, E.O. and HÖLLDOBLER, B., 2005. The rise of the ants: a phylogenetic and ecological explanation. *Proceedings of the National Academy of Sciences of the United States of America*, vol. 102, no. 21, pp. 7411-7414. http://dx.doi.org/10.1073/pnas.0502264102. PMid:15899976.